Exercise 1

- In this exercise, we want to design a comparator for two 1-bit binary numbers, x_i and y_i, with the block diagram shown in Figure 1.

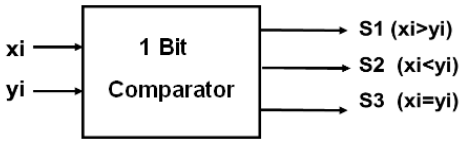


Figure 1

1. Construct the truth table.
2. Provide the logical expressions for the outputs.
3. Draw the logic-diagram of the comparator.

- Now we want to design a comparator for two 2-bit binary numbers: $X=X_1X_0$ and $Y=Y_1Y_0$, with the block diagram shown in Figure 2. It is noted that X_0 and Y_0 are the least significant bits.

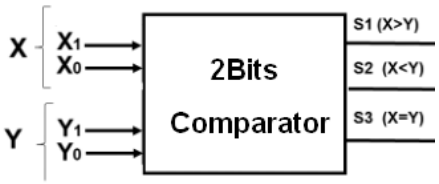
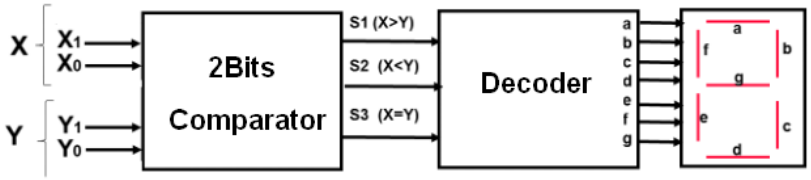


Figure 2

1. Provide the logical expressions for the outputs S_1, S_2 and S_3 in terms of the inputs X_i and Y_i with i=0,1 of the 1-bit comparator.
2. Draw the Logic-Diagram for the 2-bit comparator.

- We want to display the outputs of the comparator (S_1, S_2 and S_3) on a 7-segment display using a 3-to-7 decoder, as shown in Figure 2, to achieve the display shown in Figure 3.



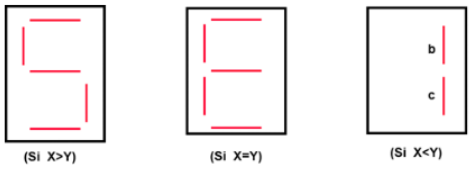
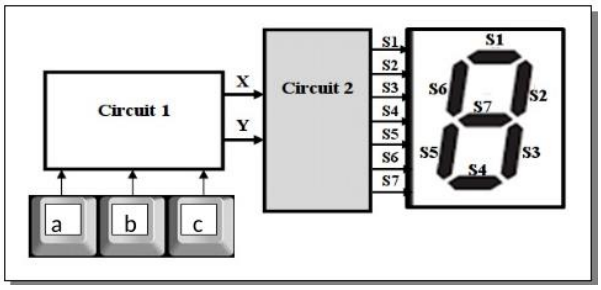


Figure 3

1. Provide the encoding table for converting the code S_1, S_2 and S_3 to the 7-segment code.
2. Deduce the internal schematic (Logic-Diagram) for the decoder.

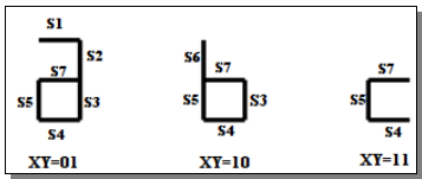
Exercise 2

We want to design a system composed of a mini-keyboard with 3 keys: "a", "b", and "c", and a 7-segment display (S1 to S7). The goal is for the display to show the letter corresponding to the key pressed. A segment iii of the display is an LED that lights up when Si=1. See the figure on the right.



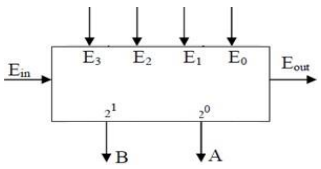
1. You are asked to synthesize the two circuits 1 and 2.

Hint: The letters on our mini-keyboard are displayed as shown in the figure on the right.



Exercise 3

Consider a combinatorial circuit with 5 input lines and 3 output lines, as shown in the figure below:



The functionality of the circuit is as follows:

- When only one input line, among E0, E1, E2, E3 is high, its number is encoded in binary on the outputs (B,A).
- If multiple lines are high simultaneously, the highest number is encoded.
- If all input lines are low, (B,A)=(00), but it is indicated by Eout=1 that this code is not validated. In all other cases, Eout=0.
- The behavior described so far is observed when Ein=1. If Ein=0, then B=A=Eout=0.

1) Construct the truth table of the encoder.
2) Derive the logical equations for the outputs A, B, and Eout in terms of the inputs E0, E1, E2, E3, and Ein.
3) Represent the Logic-Diagram of the encoder.

Exercise 4

You are tasked to design a logic circuit using a **multiplexer** (MUX), Demultiplexer and a **decoder** to implement the following Boolean function.

1) F(A,B,C)=$\bar{A}$.B+AB$\bar{C}$+ABC
2) F(A,B,C)= A·$\bar{B}$·C + $\bar{A}$.$\bar{B}$.C+AB$\bar{C}$
3) F(A,B,C)=$\bar{A}$ + AB + ABC + A·$\bar{B}$·C + A·$\bar{B}$·C.D